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Underground Construction (Tunneling)

U.S. Department of Labor
Occupational Safety and Health Administration
1989

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Underground Construction (Tunneling)

U.S. Department of Labor
Elizabeth Dole, Secretary

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Introduction

The existing OSHA regulation for underground construction (29 Code of Federal Regulations 1926.800) was originally issued under the Construction Safety Act of 1969 as 29 CFR Part 1518. These regulations were adopted by OSHA in 1971 and redesignated as 29 CFR Part 1926.800, "Tunnels and Shafts." In 1974 and 1983, OSHA proposed revisions to the existing regulations in an effort to increase worker protection in underground construction activities. A new final rule issued on June 2, 1989, adds new protective measures and provides performance-oriented language to mitigate the hazards of underground construction.

Scope and Application

The final rule applies to the construction of underground tunnels, shafts, chambers, and passageways. It also applies to cut-and-cover excavations, both those physically connected to tunnels and those that create conditions characteristic of underground construction. These hazards include reduced natural ventilation and light, difficult and limited access and egress, exposure to air contaminants, fire, and explosion.

There are about 8,100 full-time employees in this industry. According to OSHA estimates, this population sustained an average of 13.6 lost-time accidents for every 100 full-time workers in 1986, indicating a higher accident and injury rate than for other workers in the heavy construction industry. For example, the 1986 Bureau of Labor Statistics (BLS) lost-time accident rate was 6.8 per 100 full-time workers for construction, 4.1 for mining, and 4.5 for manufacturing.

Provisions of the Standard

Many provisions have been revised to give the employer the flexibility to select from a variety of appropriate and effective methods of controlling workplace hazards in underground construction. The revisions in the final rule also give additional duties and responsibilities to a "competent person."

In addition, an integral part of the standard is a safety program that focuses on instructing workers in topics relevant and appropriate to the specific jobsite.

Competent Person

A "competent person" is one who is capable of identifying existing and predictable hazards in the workplace and one who is authorized to take corrective action to eliminate them (29 CFR 1926.32 (f)). Under the revised rule, a competent person is responsible for air monitoring; for testing the atmosphere for flammable limits before restoring power and equipment and before returning to work after a ventilation system has been shut down due to hazardous levels of flammable gas or methane; for inspecting the work area for ground stability; for inspecting all drilling equipment prior to each use; and for inspecting hauling equipment before each shift and visually checking all hoisting machinery, equipment, anchorages, and rope at the beginning of each shift and during hoisting, as necessary.

Safety Instruction

The standard requires that employees be taught to recognize and avoid hazards associated with underground construction. The instruction shall include the following topics, as appropriate for the jobsite:

- air monitoring
- ventilation and illumination
- communications
- flood control
- mechanical and personal protective equipment
- explosives; fire prevention and protection
- emergency procedures--evacuation plans and check-in and check-out procedures.

All training records must be retained and made available to employees.

Access and Egress

Under this provision, the employer must provide safe access and egress to all work stations and must prevent any unauthorized entry underground. Completed or unused sections of an underground work area must be barricaded. Unused openings must be covered, fenced off, or posted with warning signs indicating "Keep Out," or other appropriate language.

Check-in/Check-out

The employer is required to maintain a check-in/check-out procedure that insures that aboveground personnel can have an accurate count of the number of persons underground in an emergency. At least one designated person is to be on duty aboveground whenever anyone is working underground. This person is also responsible for securing immediate aid for and keeping an accurate count of employees underground in case of an emergency.

A check-in/check-out procedure is not required, however, when the underground construction is sufficiently completed so that permanent environmental controls are effective and when remaining construction activity will not cause an environmental hazard or structural failure of the construction.

Hazardous Classifications

The final rule provides classification criteria for gassy or potentially gassy operations and identifies additional requirements for work in gassy operations.

Potentially Gassy Operations

Potentially gassy operations occur under either of the following circumstances:

- When air monitoring shows, for more than a 24-hour period, 10 percent or more of the lower explosive limit

(LEL) for methane or other flammable gases measured at 12 inches ± 0.25 inch from the roof, face, floor, or walls in any underground work area or

- When the geological formation or history of the area shows that 10 percent or more of the LEL for methane or other flammable gases is likely to be encountered in the underground operation.

Gassy Operations

Gassy operations occur under the following conditions:

- When air monitoring shows, for 3 consecutive days, 10 percent or more of the LEL for methane or other flammable gases measured at 12 inches ± 0.25 inch from the roof, face, floor, or walls in any underground work area; or

- When methane or other flammable gases emanating from the strata have ignited, indicating the presence of such gases; or

- When the underground operation is connected to a currently gassy underground work area and is subject to a continuous course of air containing a flammable gas concentration.

When a gassy operation exists, additional safety precautions are required. These include using more stringent ventilation requirements; using diesel equipment only if it is approved for use in gassy operations; posting each entrance with warning signs, prohibiting smoking and personal sources of ignition, maintaining a fire watch when hot work is performed, and suspending all operations in the affected area until all special requirements are met or the operation is declassified. Additional air monitoring is also required during gassy conditions.

Air Monitoring

Under the standard, the employer is required to assign a

competent person to perform all air monitoring required to determine proper ventilation and quantitative measurements of potentially hazardous gases. In instances where airborne monitoring is required by the standard to be conducted "as often as necessary," this individual is responsible for determining which substances to monitor and how frequently, taking into consideration factors such as jobsite location, geology, history, work practices, and conditions.

The atmosphere in all underground areas shall be tested quantitatively for carbon monoxide, nitrogen dioxide, hydrogen sulfide, and other toxic gases, dusts, vapors, mists, and fumes as often as necessary to ensure that prescribed limits (29 CFR 1926.55) are met. Quantitative tests for methane shall also be performed in order to determine whether an operation is gassy or potentially gassy and in order to comply with other sections of the standard ([i] [1] vii, viii, ix).

A record of all air quality tests (including location, date, time, substances, and amount monitored) is to be kept aboveground at the worksite and shall be made available to the Secretary of Labor upon request.

Oxygen

Testing is to be performed as often as necessary to assure that the atmosphere at normal atmospheric pressure contains at least 19.5 percent oxygen, but not more than 22 percent.

Hydrogen Sulfide

When air monitoring indicates the presence of 5 parts per million (ppm) or more of hydrogen sulfide, testing is to be conducted in the affected area at the beginning and midpoint of each shift until the concentration of hydrogen sulfide has been less than 5 ppm for 3 consecutive days. Continuous monitoring shall be performed when hydrogen sulfide is present above 10 ppm. Employees must be notified when the concentration of hydrogen sulfide is above 10 ppm. At concentrations of 20 ppm, an alarm (visual and aural) must signal to indicate that additional measures might be required

(e.g., respirators, evacuation) to maintain the proper exposure levels.

Other Precautions

When the competent person determines that there are contaminants present that are dangerous to life, the employer must post notices of the condition at all entrances to underground work areas and must ensure that the necessary precautions are taken.

In cases were 5 percent or more of the LEL for these gases is present, steps must be taken to increase ventilation air volume to reduce the concentration to less than 5 percent of the LEL (except when operating under gassy/potentially gassy requirements).

When 10 percent or more of the LEL for methane or other flammable gases is detected where welding, cutting, or other 'hot' work is being performed, work shall be suspended until the concentration is reduced to less than 10 percent of the LEL.

Where there is a 20 percent or more LEL, all employees shall be immediately withdrawn to a safe location aboveground, except those necessary to eliminate the hazard, and electrical power, except for pumping and ventilating equipment, shall be cut off to the endangered area until the concentration of the gas is less than 20 percent of the LEL.

Potentially gassy and gassy operations require additional air monitoring. These include testing for oxygen in the affected work areas; using flammable gas monitoring equipment (continuous automatic - when using rapid excavation machines; manual - as needed to monitor prescribed limits); performing local gas tests prior to doing, and continuously during, any hot work; testing continuously for flammable gas when employees are working underground using drill and blast methods and prior to reentry after blasting.

Ventilation

There are a number of requirements for ventilation in

underground construction activities. In general, fresh air must be supplied to all underground work areas in sufficient amounts to prevent any dangerous or harmful accumulation of dusts, fumes, mists, vapors, or gases. A minimum of 200 cubic feet of fresh air per minute is to be supplied for **each** employee underground. Mechanical ventilation, with reversible air flow, is to be provided in all of these work areas, except where natural ventilation is demonstrably sufficient. Where blasting or drilling is performed or other types of work operations that may cause harmful amounts of vapors, etc., the velocity of airflow must be at least 30 feet per minute.

For gassy or potentially gassy operations, ventilation systems must meet additional requirements. Ventilation systems used during gassy operations also must have controls located aboveground for reversing airflow.

Illumination

As in all construction operations, the standard requires that proper illumination be provided during tunneling operations as specified in 29 CFR 1926.56. When explosives are handled, only acceptable portable lighting equipment shall be used within 50 feet of any underground heading.

Fire Prevention and Control

In addition to the requirements of Subpart F, "Fire Protection and Prevention" (29 CFR 1926), open flames and fires are prohibited in all underground construction activities, except for hot work operations. Smoking is allowed only in areas free of fire and explosion hazards, and the employer is required to post signs prohibiting smoking and open flames where these hazards exist. Various work practices are also identified as preventive measures. For example, there are limitations on the piping of diesel fuel from the surface to an underground location. Also, the pipe or hose system used to transfer fuel from the surface to the storage tank must remain empty except when transferring the fuel. Gasoline is not to be used, stored, or carried underground. Gasses such as acetylene, liquefied petroleum, and methylacetylene

propadiene (stabilized) may be used underground only for hot work operations. Leaks and spills of flammable or combustible fluids must be cleaned up immediately. The standard also requires fire prevention measures regarding fire-resistant barriers, fire-resistant hydraulic fluids, the location and storage of combustible materials near openings or access to underground operations, electrical installations underground, lighting fixtures, fire extinguishers, etc.

Hot Work

During hot work operations such as welding, noncombustible barriers must be installed below work being performed in or over a shaft or raise. As mentioned earlier, during these operations, only the amount of fuel gas and oxygen cylinders necessary to perform welding, cutting or other hot work over the next 24-hour period shall be kept underground. When work is completed, gas and oxygen cylinders shall be removed.

Cranes and Hoists

The final rule contains provisions applicable to all underground construction hoisting operations performed by cranes and hoists, except personnel hoisting by cranes, which is covered by 29 CFR 1926.550(g), and material hoisting, which is covered by 1926.552(a) and (b). The final provisions for underground construction include the following:

- Securing or stacking materials, tools, etc. being raised or lowered in a way to prevent the load from shifting or snagging, or from falling into the shaft.
- Using a flashing warning light for employees at the shaft bottom and subsurface shaft entrances whenever a load is above these locations or is being moved in the shaft.
- Following procedures for the proper lowering of loads when a hoistway is not fully enclosed and employees are at the shaft bottom.

- Informing and instructing employees of maintenance and repair work that is to commence in a shaft served by a cage, skip, or bucket.

- Providing a warning sign at the shaft collar, at the operator's station, and at each underground landing for work being performed in the shaft.

- Using connections between the hoisting rope and cage or skip that are compatible with the wire rope used for hoisting.

- Using cage, skip and load connections that will not disengage from the force of the hoist pull, vibration, misalignment, release of lift force, or impact.

- Maintaining spin-type connections in a clean condition.

- Assuring that wire rope wedge sockets, when used, are properly seated.

Additional requirements for cranes include the use of limit switches, or anti-two-block devices. These operational aids are to be used only to limit travel of loads when operational controls malfunction and not as a substitute for other operational controls.

Emergencies

At work sites where 25 or more employees work underground at one time, employers are required to provide rescue teams or rescue services, that include at least two 5-person teams (one on the jobsite or within one-half hour travel time and one within 2 hours travel time). Where there are fewer than 25 employees underground at one time, the employer shall provide or make available in advance one 5-person rescue time on site or within one-half hour travel time.

Rescue team members have to be qualified in rescue procedures and in the use of firefighting equipment and

breathing apparatus. Their qualifications must be reviewed annually.

The employer must ensure that rescue teams are familiar with the jobsite conditions. Rescue team members are required to practice donning and using self-contained breathing apparatus on a monthly basis for jobsites where flammable or noxious gases are encountered or anticipated in hazardous quantities.

As part of emergency procedures, the employer shall provide self rescuers (currently approved by NIOSH and MSHA) to be immediately available to all employees at underground work stations who might be trapped by smoke or gas. The selection, use, and care of respirators shall be in accordance with 1926.103 (b) and (c). Where self-rescuers use self-contained breathing apparatus, they shall have, at a minimum, a 30-minute supply of air.

A "designated," or authorized, person shall be responsible for securing immediate aid for workers and for keeping an accurate count of employees underground.

Emergency lighting such as an acceptable portable hand or cap lamp shall also be provided to workers in their work areas unless natural lighting or an emergency lighting system provides adequate light for escape.

Recordkeeping

Under OSHA standards 29 CFR 1910.20, records of exposure to toxic substances and data analyses based on these records are to be kept for 30 years. Medical records are to be kept for at least the duration of employment plus 30 years. Background data for exposure records such as laboratory reports and work sheets need to be kept only for 1 year. Records of employees who have worked for less than 1 year need not be retained after employment, but the employer must provide these records to the employee upon termination of employment. First-aid records of one-time treatment need not be retained for any specified period.

Three months before disposing of records, employers must notify the Director of the National Institute for Occupational Safety and Health.

Hazard Communication

Under the provisions of the Hazard Communication standard (20 CFR 1910.1200), employers are responsible for informing employees of the hazards and the identities of chemicals they are exposed to when working. The standard covers both physical hazards (e.g., flammability) and health hazards (e.g., lung damage, cancer). Requirements of the rule include written hazard communication programs, labels and other forms of warning, availability of material safety data sheets, and employee information and training.

State Programs

The Occupational Safety and health Act of 1970 encourages States to develop and operate their own job safety and health plans. OSHA approves and monitors these plans. There are currently 25 State plan States of which 22 States administer plans covering both private and State and local government employment (see Regional Office listing in this booklet). Two States cover only the public sector. States with approved programs must have standards that are identical to or at least as effective as the Federal standards and adopt new or revised Federal standards within 6 months of OSHA promulgation. Until such time as a State standard is promulgated, Federal OSHA provides interim enforcement assistance, as appropriate, in these States.

Consultation Services

Free onsite safety and health consultation programs are available to employers in all States who request assistance in recognizing and correcting safety and health hazards in their workplaces. This service is funded largely by OSHA. The service is performed by State governments or private sector contractors using well-trained professional staffs.

This program is completely separate from the OSHA inspection efforts. No citations are issued or penalties proposed for any safety or health problems found in the workplace. The service is confidential. A listing of contacts for consultation programs can be found in OSHA's publication entitled **Consultation Services for the Employer (OSHA 3047).**

Related Publications

Single, free copies of the following publications can be obtained from the OSHA Publications Office, U.S. Department of Labor, 200 Constitution Avenue, N.W., Room N-3101, Washington, D.C. 20210, or from the nearest OSHA Regional Office listed in this booklet. Send a self-addressed label with your request.

OSHA 2056 - All About OSHA

OSHA 2098 - OSHA Inspections

OSHA 2226 - Excavating and Trenching Operations

OSHA 3047 - Consultation Services for the Employer

OSHA 3077 - Personal Protective Equipment

OSHA 3079 - Respiratory Protection

OSHA 3084 - Chemical Hazard Communication

OSHA 3111 - Hazard Communication Guidelines for Compliance

Hazard Communication-A Compliance Kit (OSHA 3104) may be ordered from the Superintendent of Documents, Government Printing Office, Washington, D.C., 20402, for $18.00 ($22.00 for foreign addresses); Request GPO order No. 929-022-00000-9. The kit can be ordered from GPO by phone using Visa or Mastercard; call (202) 783-3238.

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*These states and territories operate their own OSHA-approved job safety and health programs (Connecticut and New York plans cover public employees only). States with approved programs must have a standard that is identical to, or at least as effective, as the Federal standard.